

# A Shared Experience of Sciences and Mathematics Teaching during the Pandemic in the Philippines: Circumnavigating Challenges into Learning Opportunities and Communal Involvement

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## Abstract

The far-reaching consequences of the novel human coronavirus disease 2019 (COVID-19) have brought unprecedented challenges across all aspects of human endeavors, including the resonating effects on educational systems worldwide. Learners and educators have showcased their adaptability in transforming traditional teaching methodologies into new strategies and modalities. This article outlines the collective efforts of the sciences and mathematics educators at the National University Philippines, and, in part, at Centro Escolar University, Manila in responding to the pressing need to innovate learning platforms and approaches during the pandemic. Moreover, this article describes the immediate effects of institutional policies and how resilience and preparedness transform challenges into opportunities. A reflection on integrating historical, social, and cultural lessons and dimensions into science and mathematics teaching to incorporate a sense of identity and to provide contextual and synchronizing examples to the concepts is also herein provided. Educators find strength in shared experiences and communal involvement during the pandemic to circumnavigate the struggles and difficulties, viewing them as opportunities and further elevating science and mathematics education using the lens of scientific, historical, and sociocultural inquiry.

## The transition state – school closures and the radical shift to the virtual world

The novel coronavirus disease 2019 (COVID-19) rapidly spread to become the fifth documented pandemic since 1918, bringing unprecedented challenges to all sectors (Blake and Wadhwa 2020), including education (Hoofman and Secord 2021). At its peak, 188 countries imposed nationwide school closures affecting over 1.6 billion students across all levels (UNESCO 2020). Three years later, 23 countries, representing nearly 405 million learners, have yet to reopen schools fully, while 40 others still face local closures, affecting 47% of the global learner population (UNESCO 2022). The pandemic exacerbated pre-existing educational challenges, putting many students at risk of dropping out due to socioeconomic disruptions (Martin, Markhvida, Hallegatte, & Walsh, 2020). Social distancing and movement

restrictions disrupted traditional education, making the transition to new learning modalities slower than anticipated (Hew et al. 2020).

Worldwide school closures that shifted education to virtual platforms (Reyes, Isleta, Regala, & Bialba, 2024) raised concerns about how this new ecosystem affects learners' mental (Mosleh, Shudifat, Dalky, Almalik, & Alnajjar, 2022), physical (Chu & Li 2022), and social health (Farhud 2020). Anxiety and absenteeism from technological demands, productivity measurements, and information overload have been significant negative mental health impacts of online learning, even pre-pandemic (Poalses & Bezuidenhout 2018). These issues worsened with the increased demands of online modalities, compounded by the limited financial ability of lower socioeconomic students to access necessary technology. Virtual interactions, however, can foster meaningful discussions, enhancing student engagement and motivation (Saladino, Algeri, & Auriemma, 2020). Learning in science and mathematics, especially in foundational courses like introductory college chemistry, should be context-specific rather than abstract (Bransford, Bransford, Brown, & Cocking, 2000). For instance, hands-on chemistry labs that allow direct observation of reactions promote more meaningful learning than mere memorization of formulas. Grounding education in authentic situations aids deeper understanding and application to new contexts. This challenge has been particularly acute for lab courses. In response, science educators globally worked to develop online lab experiments using available resources and retrofitting strategies (Kozánek Kiss 2024) to maintain skill development in laboratory work (Reyes et al., 2024).

This article outlines the actions and advances made to ensure the continuity of education in the Philippines, highlighting how traditional methodologies have led to new modalities. It primarily focuses on current practices by science and mathematics educators at the National University (NU), Philippines, while also incorporating experiences from Centro Escolar University (CEU), Manila. The article exemplifies how teachers have innovated to assess the effectiveness of their strategies, discussing both strengths and weaknesses to identify areas for improvement. It reflects on how NU educators responded to the challenges of COVID-19, emphasizing that shared experiences in overcoming these difficulties have enhanced meaningful learning for both educators and students. This framework illustrates how educators' adaptability, resilience, and collective efforts underscore the preparedness of the science and mathematics education community for crises like the pandemic, integrating experiences through scientific, social, and cultural lenses.

### **Breaking the barriers – ensuring the continuity of learning**

In March 2020, the Philippine Department of Health (DOH) issued health alerts following the detection of localized COVID-19 transmission. The government enacted strict lockdowns and quarantine protocols under Proclamation No. 922, declaring a state of public health emergency (Parrocha 2020). This led to the closure of educational institutions, affecting over 28 million learners nationwide, including 3.5 million students in approximately 2,400 Higher Education Institutions (HEI) (UNESCO 2020; CHED 2022a). Tertiary institutions, whether public or private, secular or religious, offering specialized courses, had to find ways to continue education while protecting educators (DLSU, 2020). The Inter-Agency Task Force on Emerging Infectious Diseases (IATF-IED) enforced a National Action Plan to curb COVID-19, halting all face-to-face classes and school functions (Lopez, 2020). HEI leaders quickly implemented platforms to ensure learning continuity and practical instruction amidst the challenges.

The pandemic has negated the significant expansion of higher education in the Philippines over the last decade, rescinding the 40% growth in enrolment and the increase of HEIs from 1,710 in 2006 to 1,943 in 2016 and finally, 2,424 in 2020, as reported by the Quality Assurance Agency for Higher Education (QAA, 2018). In August 2022, the Department of Education (DepEd), the Philippine government's executive department tasked to ensure access to quality basic education (primary and secondary), announced that 425 private schools have permanently closed amid the COVID-19, based on the agency's records citing low overall enrolment and financial instability (Hernando-Malipot, 2022).

Actions and guidelines implemented by the HEIs in the Philippines mirrored the responses of neighboring countries in the installation and utility of online learning facilities encompassing private and government-supported institutions (Mulyanti, 2020). Highly industrialized countries showed better responses since online, and virtual-based curricula infrastructures were in place even before the pandemic (Parentela and Vargas, 2021). In the context of Philippine learning institutions, distance education was considered a new exploratory mode of course delivery when the pandemic hit the Pacific nation. The country was unprepared, and petitions by educators and students reflected the need for an accessible learning management system that gave flexibility and would have made adaptations and actions to emergencies, like COVID-19, more rigorously aligned to the sustained growth and continuation of instructions and teaching across all academic levels.

### **Maximizing interactions – establishing a common virtual learning space**

National University (NU) Philippines, the country's first private, non-sectarian, coeducational institution, faced operational suspension due to the emergency declaration and enhanced community quarantine in March 2020, prompting a shift to online learning. This occurred during NU's midterm period of the 3rd term in AY 2019–2020, under its trimestral system. The university paused all synchronous and asynchronous activities to allow students and educators time to adjust while safeguarding their health (NU, 2022). Coursework was completed using modular methods, and NU began formulating online learning guidelines.

As a Microsoft School since 2016 (Doctor, 2020), NU had previously used online platforms for course material repositories and submissions. However, the full transition to online learning by AY 2020–2021 required collaborative efforts among faculty, administrators, and resource persons to establish digitized learning frameworks and deliver course content through videoconferencing platforms. This shift received mixed reactions, with challenges such as (1) internet costs and connectivity, (2) availability of devices, (3) lack of online resources, (4) perceptions of online learning as inferior to face-to-face instruction, (5) overwhelming workloads, and (6) mental and health concerns. NU proactively addressed these issues by offering preparatory activities, extensive training, ensuring access to online resources, and mobilizing academic and health support systems.

### **Science and mathematics education at NU-Manila, Philippines**

The changes had drastically affected the delivery of science and mathematics courses and subjects at the NU when they first occurred. It should be noted, however, that these changes continue to impact how science and mathematics classes are taught at the university even now. The sciences and mathematics (Sci-Math) cluster of the General Education department, under the College of Education, Arts and Sciences (CEAS) of the NU-Manila, the main campus, has been catering to various programs in their required science and mathematics subjects. Table 1 summarizes the affected general education courses offered by the Sci-Math cluster when the

lockdowns were implemented to the present. Chemistry courses offered as general education subjects encompass college chemistry, inorganic, organic, and biochemistry for allied health programs, including psychology, nursing, medical technology, and dentistry. Several of these science subjects were co-shared with the College of Allied Health faculty members. All the programs had their chemistry courses delivered online. The psychology program allowed blended-type learning from August 2022 due to the university's efforts to revisit existing guidelines and allow limited in-person classes.

Table 1. List of science and mathematics courses catered by the Sci-Math cluster at NU-Manila

Subject	Course	Programs	Year and Modality
Chemistry	General and Inorganic Chemistry	Psychology	2019–2021, purely online
			2022–2023, blended learning
	Inorganic and Organic Chemistry	Nursing Medical Technology	2019–2023, purely online
			Inorganic Chemistry
	Organic Chemistry	Dentistry	2019–2023, purely online
Biochemistry	Nursing Dentistry	2019–2023, purely online	
Biology	Human Anatomy	Psychology	2019–2022, purely online
			2022–2023, blended learning
	Microbiology and Parasitology	Nursing	2019–2023, purely online
Zoology	Psychology	2019–2023, purely online	
Physics	College Physics	Psychology	2019–2023, purely online
Mathematics	Mathematics in the Modern World	All Programs	2019–2023, purely online
	College Algebra and Plane Trigonometry	Architecture	2019–2023, purely online
	Differential and Integral Calculus	Architecture	2019–2023, purely online
	Solid Mensuration	Architecture	2019–2023, purely online
	Basic Statistics	Political Science	2022–2023, purely online

In May 2022, the academic council of NU Philippines revised its policies in line with the CHED-DOH joint memorandum (CHED, 2022b). The university adopted the NU Flexible Learning Experience (NU FLEX), which introduced three different course delivery modes: (1) face-to-face, (2) remote asynchronous/synchronous learning, and (3) HyBlend learning. The HyBlend model combines in-person and virtual instruction, integrating traditional and online approaches. Unlike other hybrid models that focus on asynchronous activities, NU emphasizes regular synchronous sessions to enhance student engagement. Research by Fabriz, Mendzheritskaya and Stehle (2021) shows that students perform better when participating in synchronous discussions compared to self-paced formats.

NU invested in learning management systems and virtual platforms to enable real-time interaction, while also organizing limited in-person labs and hands-on activities where safety protocols allowed. This approach is in line with studies that highlight the importance of experiential learning for conceptual understanding in science and mathematics (Sapriati et al. 2023; Santos & Prudente 2022; Jackson, 2021). Courses were classified into three categories: Category 1, which must be delivered face-to-face per CHED guidelines; Category 2, which includes lab-based courses that can be offered face-to-face or remotely; and Category 3, which encompasses other subjects. To adapt lab-based courses to an online format, educators developed Do-It-Yourself (DIY) experiments that students could conduct at home using easily available materials, with minimal supervision and no safety risks. Virtual simulations, game-based activities, and online tours of medical facilities and museums were also used to facilitate learning.

NU provided simultaneous training for both educators and students to address challenges with online platforms, especially for implementing lab components. Interactive activities ranged from flame test demonstrations and titration simulations to virtual explorations of anatomy and physiology (Klein et al., 2021). These adaptations, through free or subscription-based platforms, helped maintain student engagement and ensured the continuity of quality education during the pandemic.

### **Science and Mathematics Education at CEU-Manila, Philippines**

Similar to NU, Centro Escolar University (CEU) remained steadfast in its commitment to providing quality education throughout the COVID-19 pandemic while prioritizing the health and safety of its students, faculty, and staff. CEU adopted a flexible learning approach, introducing the Learning Engagement and Proficiency System (LEAPS), which emphasized largely asynchronous learning complemented by on-campus laboratory classes for science courses when safety protocols allowed (CEU, 2023).

Like NU's emphasis on accessibility, CEU's asynchronous model enabled students to download materials and complete assignments at their own pace, addressing challenges related to internet connectivity. To facilitate a smooth transition to online learning, CEU implemented extensive teacher training programs, such as CEU TetraOLT (Teacher Training on Online Teaching), which equipped educators with the skills necessary to create engaging and effective online modules. Additionally, CEU launched the CEU ENGAGE initiative to foster a sense of community among students, faculty, and staff. This program offered a range of digital activities aimed at promoting student engagement and enhancing digital well-being, ensuring that the CEU community remained connected and supported during these challenging times. By adopting these measures, CEU mirrored NU's efforts to provide a high-quality educational experience amidst the pandemic.

## **Sparking the change – integrating sociocultural perspectives in science and mathematics**

Despite its devastating impact on Philippine society and education, the pandemic underscored the spirit of bayanihan, a unique Filipino concept of unity and camaraderie deeply woven into the country's cultural fabric (Bagayas, 2020). At NU and CEU, science educators swiftly implemented contingency plans to make the most of available resources. This shared experience fostered collaboration and transformed challenges into opportunities. These efforts not only promoted scientific and mathematical literacy but also integrated Filipino identity into class discussions. Filipinos are known for their resilience, passion, and commitment (Camitan and Bajin 2021; Medina 2020), traits that helped them navigate the pandemic at the individual, community, and national levels, maintaining well-being and a collective experience (Kimhi et al., 2021). Faith, family, and friends were key factors in students' resilience, highlighting the importance of communal support (Lee-Chua, 2022).

NU and CEU science and mathematics educators turned challenges into opportunities by integrating Filipino identity into class discussions while teaching required content. Various topics and strategies were used to promote continuous science and mathematics literacy, earning positive student feedback. This was reflected in online evaluations of teaching methods and the learning management system. Below is an overview of how socio-cultural aspects were integrated into science and mathematics learning, helping students connect with the world during the pandemic.

- (1) An approach streamlining the outlook of advocating scientific literacy during the pandemic is the integration of storytelling (Reyes, 2023b), narrative thinking (Reyes & Villanueva, 2024), and visuospatial reasoning (Mnguni, 2024) in science education. Storytelling touches on human psychological perception (Collins, 2020), and the sciences have stories to tell. Through narratives and the contextualization of scientific knowledge, educators can embed instructions by creating synchrony with the world. The use of stories incorporating the successes and failures of local and international scientists emphasizes the challenges they overcame and their contribution to the modern world.
- (2) Revisiting the Philippine archaic measurement systems and the country's metrification bridged cultural and historical gaps, highlighting the need for a unified measurement scheme. Discussing obsolete units revealed the ingenuity of early Filipino civilization and how their quantitative meanings were lost over time, yet remained embedded in the vernacular and culture, offering students a sociocultural perspective on metrology.
- (3) Virtual tours of the National Museum of the Philippines, covering fine arts, anthropology, natural history, and sciences, offered cultural and historical appreciation while highlighting the science and mathematics behind various exhibits (Pambansang Museo, 2022). For example, students learned about the characteristics of paints, inks, and pigments used in artworks and how to preserve centuries-old masterpieces. In mathematics, concepts like perspective, geometry, symmetry, and numeracy in art were analyzed, giving students a chance to appreciate the intersection of math and the arts (Arias-Alfonso and Franco, 2021).

- (4) Scientific, historical, and ethnocultural understanding of ancient societies is collectively considered by looking into stoneware, ceramic works, pottery, and early kitchen tools. By integrating knowledge of the sciences and the techniques for characterizing historical artifacts, students understand the technological advances that existed in the antiquated era. At the same time, documented analysis of the remaining contents of jars and ancient cookware reveal the diet of Filipino ancestors and relate it to health and other concepts in biology and biochemistry, creating overall scientific and ethnocultural linkages (Cayme 2021a; 2021b).
- (5) Science and mathematics education was integrated with the arts by analyzing literary pieces, poetry, music, dance, films, and commercials through a scientific lens. Dissecting these works for scientific accuracy helped assess students' understanding of class concepts. Critically evaluating pandemic-era commercials, particularly those claiming to eliminate viruses and bacteria, effectively gauged students' grasp of biochemistry, microbiology, and parasitology.
- (6) Using local animals as examples in zoology courses other than the usual textbook examples also provided students with a sense of familiarity with common fauna they usually encounter in their places or provinces. Actual dissections were done at home using readily available specimens during online classes.
- (7) Local plants were also utilized in botany classes to highlight Philippine flora. Plant adaptations were demonstrated using common plants to facilitate learning and appreciation, especially now that the Philippines passed the bill named "Graduation Legacy for the Environment Act 2016," requiring primary, secondary, and university students to plant at least ten (10) trees as a requirement for graduation (Chia 2019). Classes integrate studies on the Philippine indigenous tree species and their adaptability to the country's climate and characteristics of different habitats, including forest, mangrove areas, and indigenous territories, thus establishing linkages to local tribes and their practices in planting.
- (8) The emphasis of the lymphatic system and immunity topics were integrated into COVID-19 information dissemination and class discussions, given the current circumstances, to encourage and educate students on the importance of vaccination, especially for those with vaccine-hesitant persons among families. This drive has been done to support governmental efforts to increase the rate of vaccination and hasten the development of immunity towards the COVID-19 virus, helping students make informed decisions.
- (9) The Sci-Math cluster initiated a regular Lecture Series offered for the university community and opened to everyone outside NU to spearhead science and mathematics literacy through an informative discourse on topics of importance to society, thus creating a common virtual space for sharing insights and appreciation. The importance of integrating the rich scientific literature into science education was also emphasized in class instructions (Reyes, 2023a; Reyes, 2023c; Reyes & Regala, 2023).
- (10) Mathematics educators also incorporated an appreciation of the arts and culture, especially for architecture and engineering students. Mathematics of arts and design in Filipino visual arts were emphasized. For example, several types of isometry patterns were discussed along with their elegant applications in Philippine textile designs, highlighting several works of art from different tribes like that of the T'boli group. The

students were exposed to items such as blankets, clothing, and other tribal articles containing mathematical styles and refinements, for example, the pixelated appearance of fabrics associated with the ikat technique.

In addition to conventional tests, the Sci-Math cluster introduced alternative assessments, such as performance tasks and oral exams, to gauge students' understanding and spontaneity. This also served as a form of *kumustahan*, a Filipino way of checking in. Students appreciated this personal touch, as it went beyond academics. They created skits, reports, and monologues, applying mathematical concepts to real-life scenarios. Other tasks included posters, infographics, memes, songs, and *hugot* lines—witty phrases blending math and science with everyday life. Music highlighted both artistic expression and cultural connection, with foreign students recognizing its value. These methods, as seen in evaluations, helped deepen understanding by linking lessons to daily experiences, despite pandemic challenges.

The integration of socio-cultural aspects into science and mathematics education, particularly during the pandemic, has provided educators with new strategies for engaging students while focusing on core concepts. This approach, which links human experience to science and mathematics literacy, has proven essential for creating a dynamic virtual classroom that prioritizes students' needs over traditional top-down instruction. The COVID-19 crisis emphasized the importance of sociocultural integration in shaping students to make responsible, scientifically sound, and mathematically informed decisions.

## **Qualitative Insights from Student Feedback and Course Evaluations**

Due to the pandemic, traditional assessments like written exams were replaced with performance tasks, oral assessments, and project-based activities to gauge student understanding while fostering engagement. This shift aimed to provide flexibility in the virtual learning environment (Muñoz Salazar et al., 2023). Feedback from course evaluations and student reflections was largely positive, with many students noting that the new methods helped them apply theoretical concepts to real-life situations, especially within the context of Filipino socio-cultural integration. For example, in mathematics, students created posters and infographics to demonstrate their understanding of abstract concepts through culturally relevant examples.

Oral assessments were found to be less intimidating than written exams, encouraging critical thinking and reflective demonstrations of knowledge. One student remarked, "*The oral exams helped me connect the lessons to my own experiences, making them more engaging than traditional exams.*"

Students also reported that these methods kept them motivated and involved despite the lack of face-to-face interactions. Course evaluations from NU (440 students) showed: 80% felt performance tasks connected lessons to real-life scenarios, 85% found oral assessments more engaging than written exams, and 90% appreciated the flexibility of assignments, which reduced stress and improved focus. While quantitative data like test scores was unavailable due to the remote setup, the qualitative feedback indicates the success of these alternative assessments in maintaining educational continuity and supporting learning outcomes. Teacher observations during virtual lessons were also crucial in assessing student engagement, as educators monitored participation levels, interactions, and responses. Furthermore, this success was reflected in the Online Teachers Evaluation (OTE), where students provided feedback on their instructors' effectiveness in facilitating learning during remote classes. Students' feedback



indicated that these methods significantly enhanced their engagement and understanding, demonstrating the value of adapting assessments to prioritize the learner's context, especially during crises like the COVID-19 pandemic. Overall, students' responses show that these methods significantly enhanced their engagement and understanding, demonstrating the value of adapting assessments to prioritize the learner's context, especially during crises like the COVID-19 pandemic.

## **Reflective Insights on the Educators' Teaching and Learning Journey**

The sudden shift to online learning during the COVID-19 pandemic posed significant challenges for educators, especially in hands-on subjects like science and mathematics (Shevchuk, 2023). At NU and CEU, faculty quickly adapted through creativity and collaboration to maintain learning continuity, aligned with the global need for elevating creative processes among educators (Rahayuningsih, Kamaruddin, Sutrisno, & Razak, 2024). This section highlights their experiences and collective efforts in navigating these unprecedented times.

### **Collaborative Development of DIY Laboratory Experiments**

With the loss of physical lab sessions in courses like chemistry, biology, and physics, faculty designed Do-It-Yourself (DIY) experiments students could safely conduct at home. Using common household materials, students performed activities like flame tests and titration simulations, guided by detailed online instructions and video demonstrations (Chan, Kok, Razali, Lawrie, & Wang, 2022). Faculty worked closely to ensure these home-based experiments met learning outcomes and maintained safety standards. As one educator remarked, *"The sense of community among the faculty was stronger than ever, as we knew the key to overcoming these challenges was working together and supporting each other."*

### **Adoption of Digital Tools and Platforms**

The transition to online teaching required educators to quickly master new digital tools, such as video conferencing software, learning management systems, and virtual simulations. Despite the learning curve, faculty embraced these technologies, using virtual labs and digital tools to maintain the rigor of lab-based subjects and introduce new teaching methods (Otto, Bertel, Lyngdorf, Markman, Andersen, & Ryberg, 2023). As one educator shared, *"We struggled at first with student engagement in a virtual setting, but over time, we found ways to make the experience interactive and meaningful."*

### **Challenges and Resilience in Virtual Teaching**

Virtual learning introduced numerous challenges, including the difficulty of gauging student understanding and frequent internet connectivity issues. Nonetheless, NU and CEU educators demonstrated resilience by offering flexible learning options, extending deadlines, and providing individual consultations. The spirit of *bayanihan* (communal unity) was evident as faculty and students supported each other in adapting to the new learning environment. As one educator reflected, *"This experience taught us that education is not just about delivering content but understanding students' circumstances and adapting to meet their needs."*

### **Strength in Shared Experiences and Communal Involvement**

Throughout this journey, the strength of shared experiences and communal involvement was crucial. Faculty collaborated across departments and with university administrators to secure necessary resources and regularly exchange best practices. Through workshops, webinars, and

professional development sessions, educators continuously honed their digital teaching skills. As one educator noted, *"The pandemic showed us that no one can do this alone. It was through the collective efforts of colleagues, students, and administrators that we were able to rise to the occasion and continue providing quality education."*

## **Frontiers and Future Directions**

Despite the challenges posed by COVID-19, online education has surpassed traditional face-to-face classes. In the Philippines, where social interactions are integral to daily life, the restrictions brought unprecedented difficulties. The pandemic exposed vulnerabilities in the country's science and mathematics education, reflecting global weaknesses in academic systems. However, the resilient Filipino spirit, rooted in culture and history, has proven triumphant, with institutions like the National University and Centro Escolar University ensuring learning continuity while adhering to government policies. NU and CEU swiftly transitioned to online learning, offering flexibility in deadlines and resources like laptops and internet allowances for disadvantaged students. Limited in-person activities were carefully staggered, and COVID testing and tracing protocols were implemented.

Science and math educators turned challenges into opportunities by integrating social, cultural, and historical awareness into blended learning, boosting student engagement. This proactive approach increased participation in virtual discussions and activities, fostering a supportive environment where no one was left behind. The pandemic highlighted the need for equitable access to education, and Filipino educators responded with camaraderie by organizing mobile libraries, donation drives, and expanding learning access through online platforms, TV shows, and virtual tours.

Integrating socio-cultural dimensions into science and math education gave students a stronger sense of identity. This multidisciplinary approach kept lessons relevant and creative, emphasizing the role of history and culture in understanding the world. Despite the pandemic's challenges, it strengthened community spirit and innovation in the Philippine educational system, paving the way for a transformative approach. NU and CEU educators now advocate for more inclusive, interdisciplinary teaching, enriching student engagement and connecting science and math to real-life cultural experiences. Student feedback shows that these socially relevant curricula enhance motivation and interest. By linking science and math to familiar human experiences, educators have demonstrated the value of a multidisciplinary approach in fostering scientific literacy.

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